SURVEY METHODS FOR THE AMERICAN BURYING BEETLE (NICROPHORUS AMERICANUS) IN OKLAHOMA AND ARKANSAS

J. Curtis Creighton, Mark V. Lomolino and Gary D. Schnell

Oklahoma Biological Survey
University of Oklahoma
Norman, Oklahoma 73019
Telephone: 405-325-4034

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Introduction

The American burying beetle (*Nicrophorus americanus*) is the largest member of the genus *Nicrophorus* in North America. It ranges from 1 to 1.5 inches (25-45 mm) in length. Like most other burying beetles, the American burying beetle has four red-orange spots on its wing covers (elytra). It can be distinguished from other North American burying beetles by its larger size and its orange-red pronotum and frons (see Figure 1).

The disappearance of the American burying beetle from over 90 percent of its historic range underscores the need for consistent, reliable methods when surveys for the beetle are conducted (U.S. Fish and Wildlife Service, 1991). The methods outlined below have proven to be successful in capturing the American burying beetle. Following these methods should help to ensure the validity of survey results. Furthermore, data gathered using these methods will allow for easier comparison of results from different surveys.

Site Selection

American burying beetles are generalists, occurring in many different habitats. Therefore, surveys should be conducted in a broad range of habitats. In addition, individual beetles have been recorded moving over 4 miles (6.5 km) in only a few days. For this reason, there is no need to locate survey sites less than one-half mile (0.8 km) apart. If large areas are being surveyed, sites can be located as much as one mile (1.6 km) apart. Individual sites should be trapped for three nights.

Trapping Methods

Baited pitfall traps are the most effective method known for surveying for American burying beetles. At each site, eight pitfall traps are placed at 20-m intervals along a transect line (Figure 2).

Each pitfall trap consists of two, 24-oz. (0.7-L) plastic cups stacked together and buried in the ground so that the lip of the top cup is flush with the soil surface (Figure 3). A plastic dome should be placed over each trap to keep out rain. A 10 x 10 inch (25 x 25 cm) piece of wood (held above the pitfall trap with 6-inch [15 cm] legs made of wooden dowls) can be substituted for a dome if one is not available. The bait is placed in the bottom of a 6-oz. (0.2-L) styro-foam cup that has had all but the bottom inch (2.5 cm) of the cup trimmed away. The trimmed-down sytro-foam cup is suspended above the plastic cups with a short length of wire (see Figure 3).

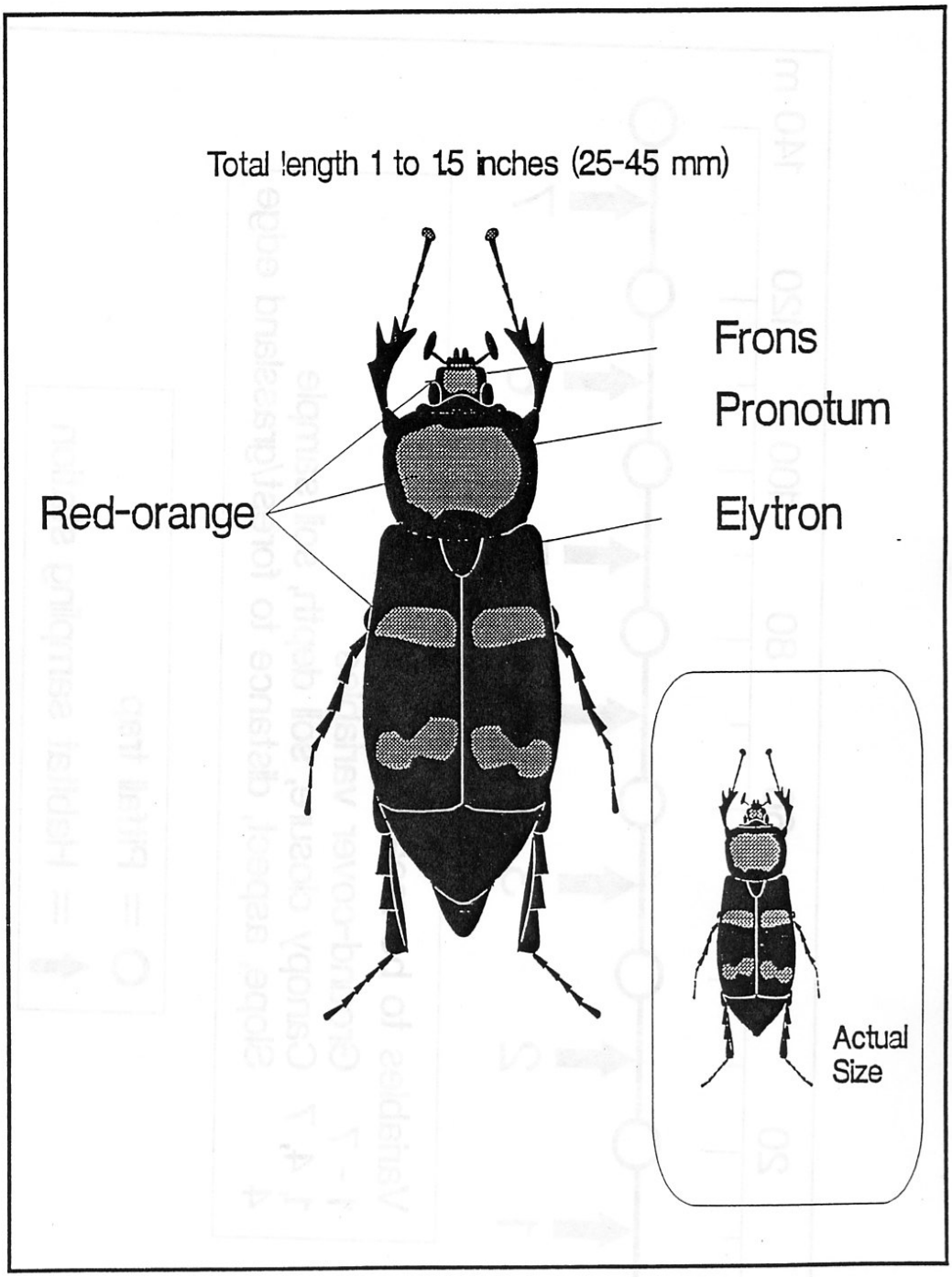

Figure 1. The Amerian burying beetle.

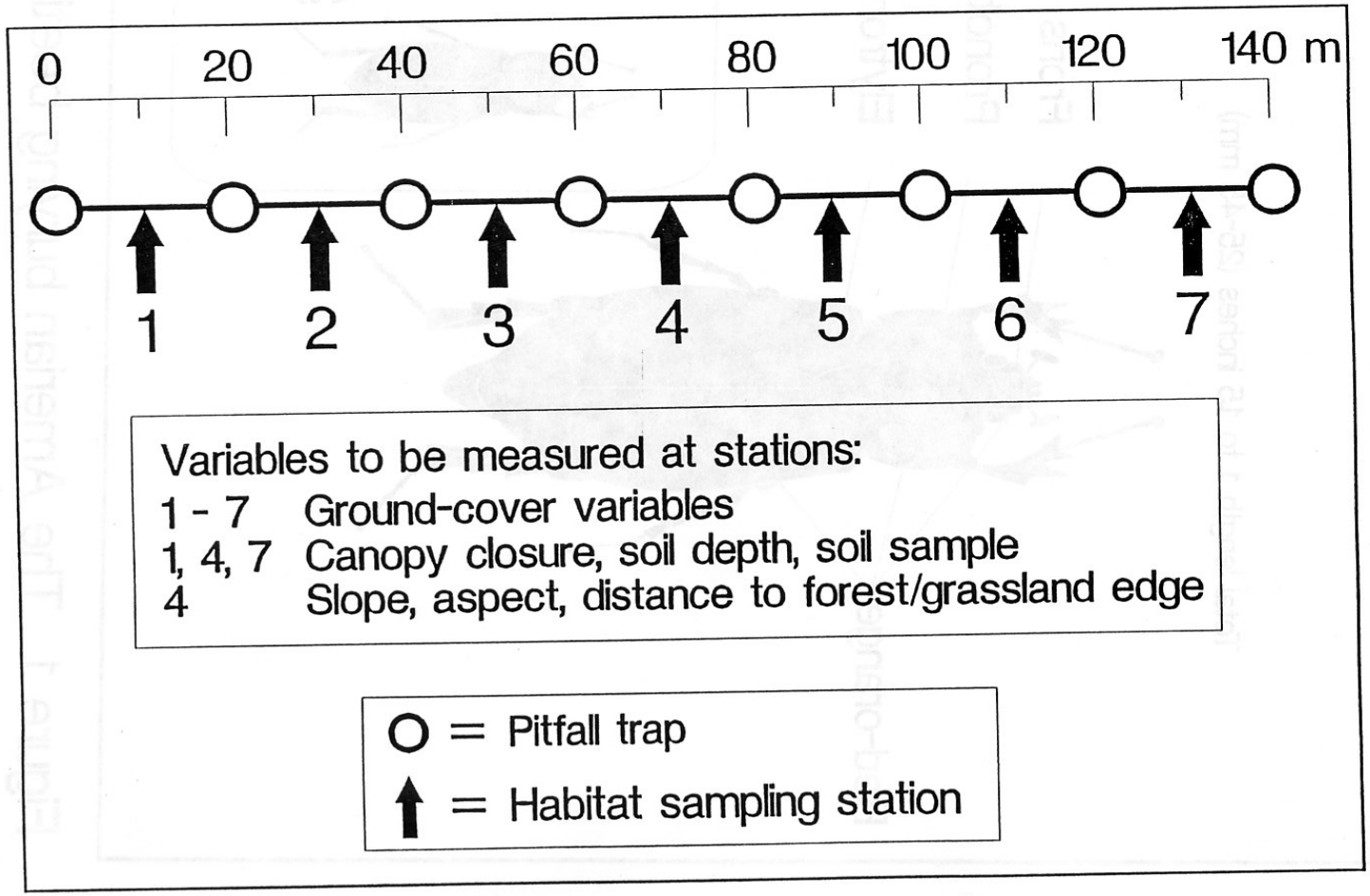

Figure 2. Diagram of survey transect.

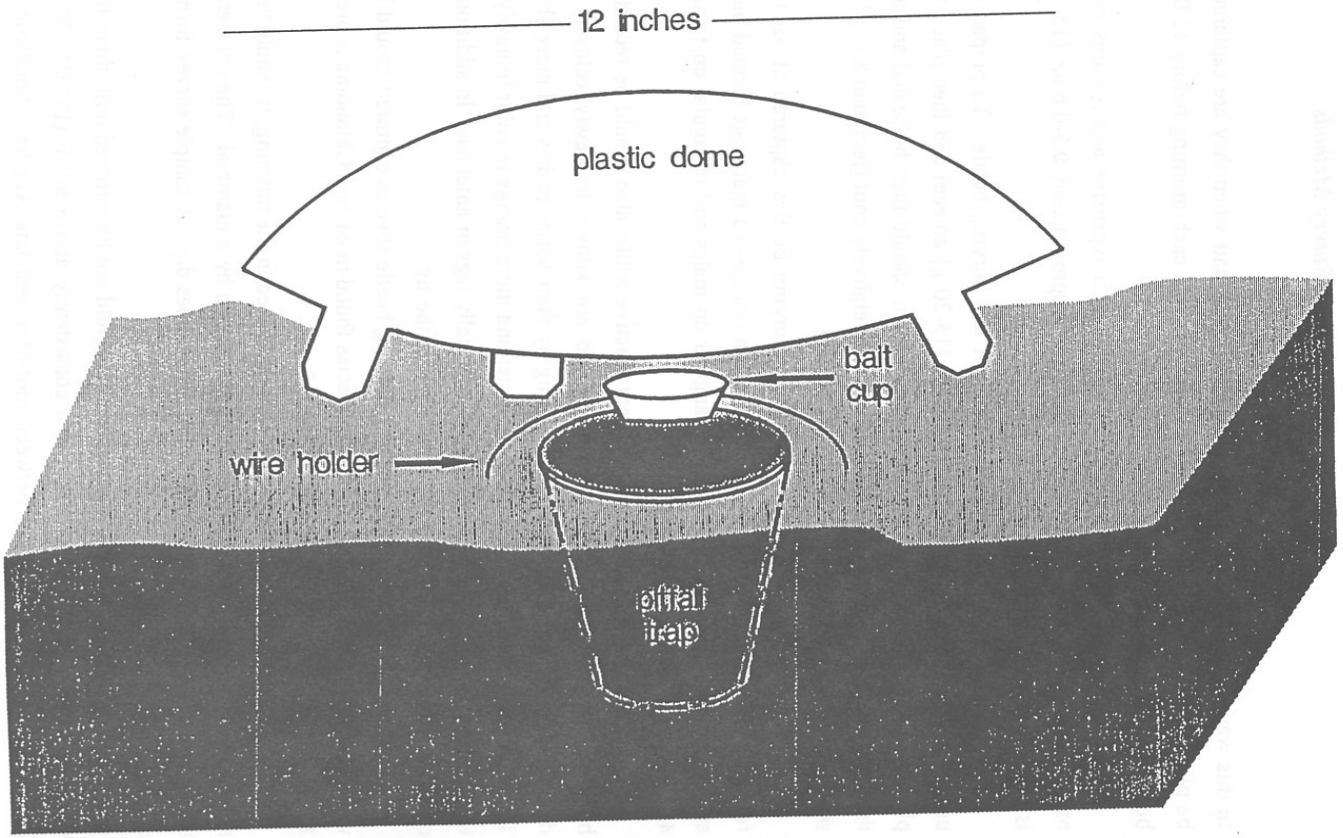

Figure 3. Diagram of pitfall trap.

In this way, beetles do not have direct access to the bait when they are captured. Traps should be placed in the field before 17:00 DST and checked each morning before 10:00 DST to avoid beetle mortality due to excessive heat.

Unskinned chicken is the preferred bait. It is inexpensive and remains moist longer than other baits because most of its fat is in the skin. Approximately 0.5-0.6 oz. (15-20 g) of chicken is placed in each pitfall trap.

Fresh bait is not an effective attractant of any burying beetle. To prepare the chicken for use, chop it up into small cubes (0.5-0.6 oz. [15-20 g] apiece) and then place the cubes into a plastic jar. Do not fill the jar completely. The jar should then be sealed and allowed to sit in the sun for a minimum of one day. If the day is relatively cool (less than 85° F [29° C]), the bait should sit in the sun for a longer period of time.

The numbers of each sex of American burying beetles captured at each site should be recorded. The sexes can be separated based on orange-red markings located between the frons and mandibles: these markings are rectangular on males and triangular on females (see Figure 4).

The number of newly eclosed and reproductive adults also should be recorded. Adults that have recently (less than two weeks) pupated are known as newly eclosed. They can be distinguished from the previous year's young by their softer bodies and more shiny appearance. The red-orange pronotum appears to be lighter and more orange in color in newly eclosed adults. Older adults are often missing body parts, especially legs or antennae. In addition, the mandibles of older adults appear to be a bit more worn at the tip.

The numbers of individuals of other burying beetle species captured should be recorded. A written description of the burying beetle species found in eastern Oklahoma is presented in Table 1. An identification key is found in Table 2.

If a pitfall trap is disturbed prior to being checked in the morning, it should be noted whether the trap was: intact but with bait missing; or dug up by a mammal. The chicken should always be replaced if it is taken during the night or becomes dry. A sample survey form is included in the appendix.

Surveys for the American burying beetle should not be initiated until there has been a week where minimum temperatures have been consistently above 60° F (15° C). In Oklahoma and Arkansas, we conduct surveys between mid-May and late August. American burying beetle activity is influenced by weather conditions. For each night that the ambient temperature

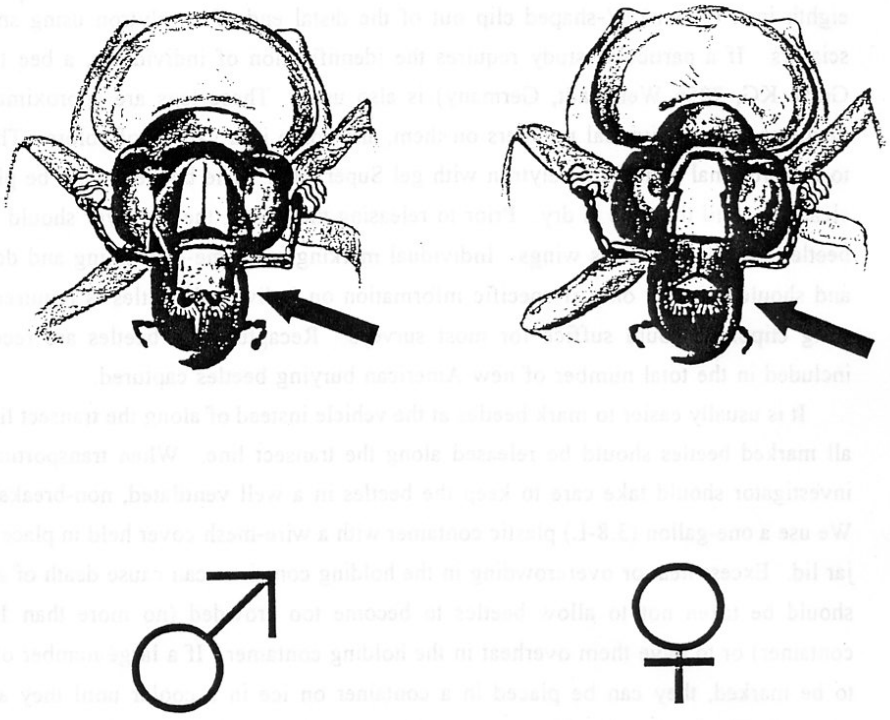

Figure 4. Characteristics distinguishing male from female American burying beetles.

dropsbelow 60° F (15° C) during the sampling period, the site should be sampled for another night. The site also should be retrapped if rainfall is heavy after dusk.

Marking Beetles

All American burying beetles captured need to be given a permanent mark by taking an eighth inch (3 mm), V-shaped clip out of the distal end of an elytron using small dissecting scissors. If a particular study requires the identification of individuals, a bee tag (from Chr. Graze KG, 7056 Weinstadt, Germany) is also used. These tags are approximately 1-mm in diameter, have individual numbers on them, and come in a variety of colors. The tag is glued to the proximal end of one elytron with gel Super Glue. The beetle should be placed in a dry, clean tub until the glue is dry. Prior to releasing the beetle, the surveyor should make sure the beetle can still spread its wings. Individual marking is a time-consuming and delicate process and should be done only if specific information on individual beetles is required. Otherwise, wing clipping should suffice for most surveys. Recaptures of beetles are recorded but not included in the total number of new American burying beetles captured.

It is usually easier to mark beetles at the vehicle instead of along the transect line. However, all marked beetles should be released along the transect line. When transporting beetles, the investigator should take care to keep the beetles in a well ventilated, non-breakable container. We use a one-gallon (3.8-L) plastic container with a wire-mesh cover held in place with a mason jar lid. Excess heat or overcrowding in the holding container can cause death of a beetle. Care should be taken not to allow beetles to become too crowded (no more than 10 beetles per container) or to have them overheat in the holding container. If a large number of beetles need to be marked, they can be placed in a container on ice in a cooler until they are marked or released. The beetles should not be held for more than one-half hour before being released.

Accidental Death of Beetles

The handling of all endangered species is strictly regulated by the United States Fish and Wildlife Service. When surveying for American burying beetles, a copy of the federal permit should be in your possession at all times. The handling of dead American burying beetles also is under strict regulation. They cannot be added to a private collection and only the United

States Fish and Wildlife Service is authorized to determine the proper disposition of beetles killed during surveys.

All American burying beetles killed during surveys need to be accounted for and an accidental-death form needs to be filled out as quickly as possible (see sample form in the appendix). The following information is to be noted:

(1) date beetle found dead;

(2) county, state, legal description (township and range) and any other information concerning location (i.e. trap number, site number or survey name);

(3) general habitat;

(4) as accurately as possible, the cause of death (previously, causes of death have included heat exposure, predation, and drowning);

(5) sex and age of beetle (whether it is a newly eclosed or reproductive age adult);

(6) name of individual that found beetle.

At a later time, the master permittee will note where the beetle was deposited. If the specimen cannot be prepared immediately, it should be placed in a sealable, rigid plastic container so the beetle is not crushed. To avoid mixing up specimens, no more than one beetle should be kept in a container. Each accidental-death form has a specimen number. A copy of this number should be placed in the container with the beetle so specimens do not become mixed up. The container should then be put on ice until the beetle can be prepared. Specimens are to be placed in the care of the field supervisor and then reported to the United States Fish and Wildlife Service as soon as possible.

Recording Habitat Variables

Habitat data are collected at all sites surveyed for the American burying beetle, including sites where American burying beetles were not captured. Each transect has seven habitat sampling stations with one station half-way between each pair of adjacent pitfall traps (traps are 20 m apart). Figure 2 illustrates where the sampling stations are located along the survey transect and lists data to be collected at each station. A sample habitat-data form is found in the appendix.

A habitat-sampling station is considered to be the area within a 0.5 x 0.5 m wooden frame placed on the ground. The investigator notes the presence of grasses, herbs, mosses, rocks, leaf litter, shrubs less than or equal to 2 m in height, shrubs greater than 2 m in height and woody

vegetation with dbh (diameter breast height) greater than 10 cm at each of the seven sampling stations.

Percent of canopy closure (to nearest percent), soil depth (in decameters), and a soil sample should be taken at stations 1, 4, and 7. Canopy closure is measured with a spherical densiometer (concave Model C, Forestry Suppliers, Inc., Jackson, Mississippi). The procedure follows Lemmon (1957) and is outlined on the inside cover of the densiometer (copy is included as Appendix 2). A soil sampler (Oakfield Apparatus Co., 19" tube sampler, Forestry Supplier, Inc., Jackson, Mississippi) is used to measure the depth of the soil, as well as to collect the soil sample. The three soil samples from each site are placed in a single spunbound olefin sampling bag (4.5 x 6 inch [11 x 15 cm, Ben Meadows Co., Atlanta, Georgia]) with the number of the survey site recorded on the bag.

The remaining data should be collected at station 4 only. The slope of the terrain is measured with an Suunto optical reading clinometer (Model PM-5-360 PC, Forestry Suppliers, Inc., Jackson Mississippi), and the slope's aspect is measured with a compass (in degrees from magnetic north). The distance to the nearest forest edge (recorded in grassland sites) or to edge of an open area (recorded in forested sites) is measured in meters with a rangefinder (Ranging Measuring Systems, Model 620, Forestry Suppliers, Inc., Jackson, Mississippi). At a site with scattered trees and open areas (such as a savannah), the distance is recorded as zero.

Reporting of Survey Results

The results of surveys for American burying beetles are sent to the United States Fish and Wildlife Service in Tulsa, Oklahoma and the Oklahoma Natural Heritage Inventory (Oklahoma Biological Survey) in Norman, Oklahoma.

References

Lemmon, P. E. 1957. A new instrument for measuring forest overstory density. J. Forestry 55:667-668.

U.S. Fish and Wildlife Service. 1991. American burying beetle recovery plan. U.S. Fish and Wildlife Service, Newton Corner, Massachusetts.

TABLE 1. Description of burying beetles found in eastern Oklahoma and western Arkansas.

Nicrophorus americanus: Four elytral spots. Orange-red pronotum and frons distingiush this species from all other North American burying beetles.
Nicrophorus orbicollis: Black pronotum with some texturing to it. Four orange spots on elytra (two/elytron) that do not extend to edges of elytra. Typically, it is the most common species in wooded habitats.
Nicrophorus marginatus: Similar to *N. orbicollis* except that each pair of elytral spots on is connected along lateral edge of elytron. Species found almost exclusively in grassland areas.
Nicrophorus sayi: Very similar to *N. orbicollis* except femur of each back leg is distinctly curved instead of straight. Also, proximal pair of elytral spots extend to lateral edge of the elytra. Active in early spring and quite rare after late June.
Nicrophorus tomentosus: Pronotum covered with fine, golden hairs. Easily distinguished from all other species by this characteristic. Found in variety of habitats.
Nicrophorus pustulatus: Relatively dark appearance with faint or absent elytral spots. Four small, orange spots may be visible at distal end of elytra (two spots/elytron).
Nicrophorus carolinus: Similar to *N. orbicollis* except that pronotum very smooth and domelike. Usually found near large rivers.

Table 2. Key to burying beetles of eastern Oklahoma and western Arkansas.

1A. Pronotum covered with fine, golden hairs..... *tomentosus*
1B. Pronotum not covered with hairs.....2

2A. Pronotum and frons red-orange..... *americanus*
2B. Pronotum and frons black.....3

3A. Elytral spots faint or absent..... *pustulatus*
3B. Elytral spots present.....4

4A. Pronotum round, smooth and domelike..... *carolinus*
4B. Pronotum not round, smooth or domelike..... 5

5A. Femur of back leg distinctly curved..... *sayi*
5B. Femur of back leg straight..... 6

6A. Spots on each elytron connected on lateral edge of elytron..... *marginatus*
6B. Elytral spots distinct..... *orbicollis*

Appendix 1

AMERICAN BURYING BEETLE SURVEY FORM

Time:_____ Date:_____ (D/M/Y) Plot/Transect Number:_____ Survey Night: 1 2 3

Surveyor:_____ County_____ State____

Legal Description_____Habitat Description:_____

Temp: Min_____ Max_____ °F Wind_____mph Cloud Cover_____%

Population: Wild__ Reintroduced__ Relocated__ (If Relocated/Reintroduction See Appropriate Data Form)

Trap No.	*americanus*	*arbicollis*	*tomentosus*	*pustulatus*	*marginatus*	*other*
1. P GTI GDU						
2. P GTI GDU						
3. P GTI GDU						
4. P GTI GDU						
5. P GTI GDU						
6. P GTI GDU						
7. P GTI GDU						
8. P GTI GDU						
Totals						

Sex	Old	New	Age Unknown	Recaptures	Newly Marked
Males					
Females					

Years Surveyed:

Comments:

Max/Min temp for previous 24-hour period: other weather data refer to current conditions. Date and time refer to when trap checked; P=Bait present; GTI=Bait gone trap intact; GDU=Bait gone trap dug up; OLD=breeding adult; NEW=newly eclosed adult; UNK=age cannot be determined. Newly marked males and females refers to color, number of bee tag, and age of beetle (e.g. R54[old]). Recaptures refer to color and number of bee tag on beetles that have been previously marked

Form modified from Creighton et al. 1993, distributed by the US Fish & Wildlife Service Updated 6/2002

AMERICAN BURYING BEETLE SURVEY FORM

Time:_____ Date:_____ (D/M/Y) Plot/Transect Number:_____ Survey Night: 1 2 3

Surveyor:_____ County_____ State____

Legal Description_____Habitat Description:_____

Temp: Min_____ Max_____ °F Wind_____mph Cloud Cover_____%

Population: Wild__ Reintroduced__ Relocated__ (If Relocated/Reintroduction See Appropriate Data Form)

Trap No.	*americanus*	*arbicollis*	*tomentosus*	*pustulatus*	*marginatus*	*other*
1. P GTI GDU						
2. P GTI GDU						
3. P GTI GDU						
4. P GTI GDU						
5. P GTI GDU						
6. P GTI GDU						
7. P GTI GDU						
8. P GTI GDU						
Totals						

Sex	Old	New	Age Unknown	Recaptures	Newly Marked
Males					
Females					

Years Surveyed:

Comments:

Max/Min temp for previous 24-hour period: other weather data refer to current conditions. Date and time refer to when trap checked; P=Bait present; GTI=Bait gone trap intact; GDU=Bait gone trap dug up; OLD=breeding adult; NEW=newly eclosed adult; UNK=age cannot be determined. Newly marked males and females refers to color, number of bee tag, and age of beetle (e.g. R54[old]). Recaptures refer to color and number of bee tag on beetles that have been previously marked

Form modified from Creighton et al. 1993, distributed by the US Fish & Wildlife Service Updated 6/2002

AMERICAN BURYING BEETLE ACCIDENTAL-DEATH FORM

SPECIMEN NUMBER_____

DATE FOUND:_____
Day Month Year

SITE DESCRIPTION

COUNTY:_____

STATE:_____

LEGAL DESCRIPTION OF SITE:_____

OTHER INFORMATION ON SITE LOCATION:_____

HABITAT DESCRIPTION:_____

_____

BEETLE DESCRIPTION

CAUSE OF DEATH:_____

_____

SEX: MALE FEMALE

AGE: NEWLY ECLOSED OLD UNKNOWN

OTHER COMMENTS:_____

_____

OTHER INFORMATION

COLLECTOR:_____

WHERE DEPOSITED (to be completed by master permittee):_____

_____

1993 AMERICAN BURYING BEETLE HABITAT-DATA FORM

SITE INFORMATION(Make sure same as on burying beetle survey form)_____

_____OBSERVER:_____DATE:_____

HABITAT:_____

Sampling Station 1.

GRASS	HERB	LITTER	ROCK	SHRUB	TREE	MOSS
PRESENT	PRESENT	PRESENT	PRESENT	PRESENT	PRESENT	PRESENT
ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
				≤2 m >2 m		

CANOPY N____ E____ S____ W____ **SOIL DEPTH(DM):** 0 >0-1 >1-2 >2-3 >3-4 >4

Sampling Station 2.

GRASS	HERB	LITTER	ROCK	SHRUB	TREE	MOSS
PRESENT	PRESENT	PRESENT	PRESENT	PRESENT	PRESENT	PRESENT
ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
				≤2 m >2 m		

Sampling Station 3.

GRASS	HERB	LITTER	ROCK	SHRUB	TREE	MOSS
PRESENT	PRESENT	PRESENT	PRESENT	PRESENT	PRESENT	PRESENT
ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
				≤2 m >2 m		

Sampling Station 4.

GRASS	HERB	LITTER	ROCK	SHRUB	TREE	MOSS
PRESENT	PRESENT	PRESENT	PRESENT	PRESENT	PRESENT	PRESENT
ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
				≤2 m >2 m		

CANOPY N____ E____ S____ W____ **SOIL DEPTH(DM):** 0 >0-1 >1-2 >2-3 >3-4 >4
DISTANCE TO EDGE FOREST/OPEN(M): _____ASPECT: _____SLOPE(%):_____

Sampling Station 5.

GRASS	HERB	LITTER	ROCK	SHRUB	TREE	MOSS
PRESENT	PRESENT	PRESENT	PRESENT	PRESENT	PRESENT	PRESENT
ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
				≤2 m >2 m		

Sampling Station 6.

GRASS	HERB	LITTER	ROCK	SHRUB	TREE	MOSS
PRESENT	PRESENT	PRESENT	PRESENT	PRESENT	PRESENT	PRESENT
ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
				≤2 m >2 m		

Sampling Station 7.

GRASS	HERB	LITTER	ROCK	SHRUB	TREE	MOSS
PRESENT	PRESENT	PRESENT	PRESENT	PRESENT	PRESENT	PRESENT
ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
				≤2 m >2 m		

CANOPY N____ E____ S____ W____ **SOIL DEPTH(DM):** 0 >0-1 >1-2 >2-3 >3-4 >4

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A New Instrument for Measuring Forest Overstory Density[1]

A new instrument called a "spherical densiometer" has been described for estimating forest overstory density.[2] This pocket-type instrument employs a mirror with spherical curvature which makes possible the reflection of a large overhead area. A grid is used to estimate percentage of this overhead area covered with forest canopy. Estimation is usually from a point near the forest floor. Adequate sampling gives the average canopy of a forest area.

Two models, A and B (Figs. 1 and 2), have been adopted as standard. Each employs a highly polished chrome mirror 2½ inches in diameter and having the curvature of a 6-inch sphere. The convex side of the mirror is used in Model A and the concave side in Model B. Each has some advantages over the other.

The mirrors are mounted in small wooden recessed boxes with hinged lids similar to compass boxes. The over-all dimensions are about 3½ x 3½ x 1⅛ inches. A circular spirit level is mounted (recessed) beside the mirrors. Positive slide fasteners are provided in Model B which allow the lid to open to an angle of about 45 degrees.

Cross-shaped and circular grids with squares and dots are used to estimate overstory coverage by tree crowns. Grids are of two kinds: (1) those scratched upon the surface of the mirror, Model A, and (2) those superimposed between the mirror and the eye, Model B.

The cross-shaped grid scratched upon the convex surface of the mirror in Model A has 24 quarter-inch squares (Fig. 3A). Instructions for using the densiometer and cumulative values for the squares on the grid are shown on a chart that is attached to the inside of the box lid (Fig. 3B). It is easier and faster to estimate the relative amount of overstory coverage with this instrument by assuming the presence of four equi-spaced dots in each square and by counting dots representing openings in the canopy. The percentage of overstory density is then assumed to be the complement of this number. Each assumed dot is assigned a value of one percent in this case. A slight discrepancy exists between estimations using the squares and estimations by counting assumed dots, because there are only 96 dots in the entire grid area. Cumulative values of the squares shown in the chart add up to 100 percent for the entire area within the grid. If desired, one may calculate the exact percentage values for each assumed dot and thereby make the two methods of use exactly comparable.

Model B has a circular grid. The circle is 1½ inches in diameter superimposed over quarter-inch squares. Each square has four equi-spaced dots (Fig. 4A). This grid is made from a positive print of a photographic film mounted between thin sheets of plexiglass and fitted into the window of the box lid. Instructions for operating Model B are given on a chart mounted on the bottom of the instrument box (Fig. 4B). The operator estimates overstory density by counting the dots representing overstory openings and assuming this to represent the percentage of noncovered overstory area. Here again a slight discrepancy exists because there are only 96 dots included within the area of the circular grid. Exact percentage values for each dot may be calculated to estimate the entire circular area as 100 percent. This refinement is not considered necessary for ordinary use of the instrument.

Instruments can be developed with different kinds, sizes, and shapes of grids and with mirrors of different curvatures. However standardization of these properties is necessary to provide comparable information that can be duplicated. The instruments described have been thoroughly tested and have given satisfactory results with most western conifers. We believe the spherical densiometer described (either Model A or B) will serv

[1] *Editor's note.*—At the request of the author the reader's attention is called to the comercial availability of this instrument. See page 696.

[2] Lemon, Paul E. 1956. A spherical densiometer for estimating forest overstory density. Forest Sci. 2:314-320.

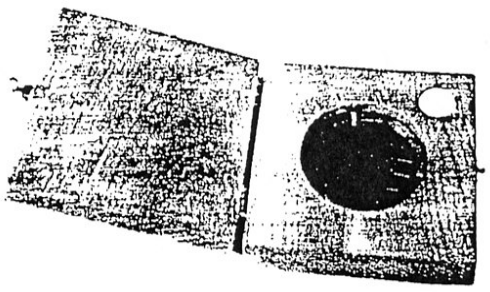

FIG. 1.—Spherical densiometer, Model A, with estimating grid scratched on the surface of the convex mirror.

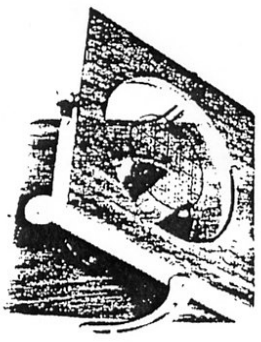

FIG. 2.—Spherical densiometer, Model B, with estimating gr superimposed between the eye and the surface of the concav mirror.

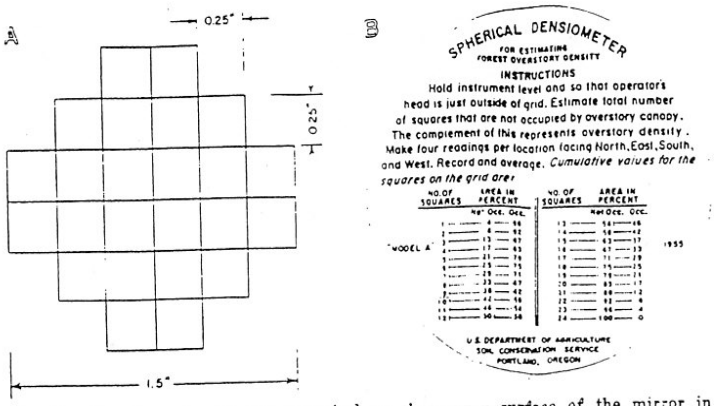

FIG. 3.—(A) Cross-shaped grid scratched on the convex surface of the mirror in Model A. Each square is ¼ inch on a side. (B) Instructions for using Model A. This is fastened to the inside of the lid of the mounting box.

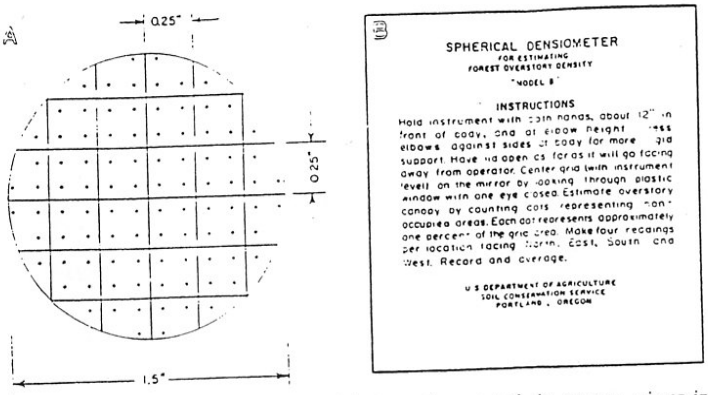

FIG. 4.—(A) Circular grid superimposed between the eye and the concave mirror in Model B. Each square is ¼ inch on a side. (B) Instructions for using Model B. This is fastened to the bottom of the mounting box.

the needs of practicing forester, range conservationist, and plant ecologist or those of most scientists doing highly technical work.

Operators need a little training to become consistent in the use of the instrument. Judgment and experience is needed to differentiate between overstory areas that are considered completely covered by the overstory and those that have thin but uniformly distributed coverage. In the latter case it may be necessary to estimate the area of many small irregular openings and reduce the percentage overstory density by the sum of these. Training and experience are needed for each different forest species or type because of the differences in overstory characteristics. The season of the year is important when making measurements in forests containing deciduous species.

Experience has shown that sufficient accuracy can be attained with the spherical densiometer by holding it as nearly level as possible in the hand. This is made possible by installing a circular spirit level in the mounting box. No mechanical support, such as a tripod, is needed. This adds to the practicability of the instrument in use.

A large number of measurements of overstory density have been made to test the instrument. One such study involved the measurement of overstory density at points in 28 different forests. Measurements were made at each point by four different operators each using instrument Model A and Model B. The results were subjected to an analysis of variance to determine consistency of measurements. There were no significant differences among measurements made by different operators or with different instruments and none of the interactions were significant. The differences due to forests, however, were highly significant—above the 99 percent level of probability. Under similar conditions one can expect variations in overstory density measurements to be within ±1.3 percent, ±2.4 percent and ±3.1 percent at probability levels of 70, 95, and 99 percent respectively. These variations amount to about 2, 3, and 4 percent when the standard deviation is expressed in terms of the overstory at the point of measurement (coefficient of variation).

Another study involved placement of 416 different forest overstory measurements into 5 percent overstory density classes. Variation around the mean within each class was calculated and the standard deviations and coefficients of variation plotted against the overstory density classes. It was found that variation among measurements increased as the overstory being measured decreased—only slightly when overstory density decreased from 100 down to about 60 per cent but rapidly thereafter. When placing overstory density into 5 percent classes with the spherical densiometer, reliability in the order of about 5 percent can be expected so long as one is measuring forests that have more than about 50 percent overhead canopy. Since one naturally estimates percentage of overstory area *not* covered in dense forests and overstory area *covered* in open forests, estimations of overstory density when placed in classes will seldom vary more than ±5 percent.

Loss in reliability of overstory density measurements results from placing forests in overstory density classes based on measurements with the spherical densiometer as contrasted with using the actual measurements. For instance, reliability of about ±1.3 percent can be obtained when actual measurements are used whereas the reliability is reduced to about 5 percent when classes are used.

PAUL E. LEMMON
Soil Conservation Service
U. S. Department of Agriculture
Washington, D. C.

Amendments to
Creighton et al.
Survey Methods for the American burying beetle in Oklahoma and Arkansas

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1. Dome cover over pitfall traps should be secured to the ground so wind or animals cannot uncover the trap and allow sun and rain to penetrate trap.

2. During capture and holding ABB's should not be exposed to temperatures greater than 77°F or direct sun for even a few hours, this will cause mortality.

3. Plastic cups of the pitfall trap should not be flush with the ground. The lip of the cup should be 1/2" to 3/4" above the ground surface. This will prevent the cups from flooding and the beetles from drowning due to runoff.

4. Traps should be at least 7 m away from ant colonies. A group of ants can kill a beetle.

5. Tagged beetles should be held solitarily in a container for at least 5 minutes to allow glue to dry.

6. Close traps if weather is predicted to consist of heavy rainfall.

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American Burying Beetle Permittees
Provided by the U.S. Fish and Wildlife Service

Below is a comprehensive list of individuals/companies in the surrounding area that currently hold permits for surveying for American burying beetles. The company you choose is solely at your discretion. The Service will not provide recommendations or advice as to which company to choose, nor will we provide any guarantees as to the quality of work. The Services only role in this matter is to provide a list of individuals/companies legally authorized to survey for the beetle.

Burns & McDonnell 9400 Ward Parkway Kansas City, MO 64114 816-822-3267 fax 816-333-3690	Dr. Gary Schnell, Associate Director Collections and Research University of Oklahoma Sam Noble Oklahoma Museum of Natural History Norman, Oklahoma 73072-7029 405-325-5050 fax 405-325-7699
Eagle Environmental, Inc. PO Box 780 202 East 2nd Avenue, Suite 107 Owasso, OK 74055 918-272-7656 fax 918-272-0596	Roberg Environmental Consulting Services 410 East Cricket Lane Cabot, Arkansas 72023 501-671-2334 fax 501-671-2110
Dr. Stuart Woods Conners State College 2501 North 41st Street Muskogee, Oklahoma 74403 918-687-6747	William Wyatt Hoback University of Nebraska 905 West 25th Street Kearney, Nebraska 68849 308-865-8602 fax 308-865-8045
Enercon Services, Inc. 6525 N. Meridian, Suite 503 Oklahoma City, OK 73116 405-722-7693 fax 405-722-7694	